Partial Replacement of Cement with Marble Powder

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Abstract- *An experimental study is conducted to evaluate the workability and strength characteristics of hardened concrete, by partially replacing the cement by various percentages of marble powder for M20 grade of concrete at different ages. The mixes were designed using IS Code method. In this project, properties of concrete have been assessed by partially replacing cement with marble powder.The cement has been replaced marble powder accordingly in the range of 0% (without marble powder), 5%, 10% and15% by weight of cement for M20 mix. Concrete mixtures were produced, tested and compared in terms of compressive, flexural and split strength with the conventional concrete.*

Marble powder is an industrial by-product material produced from the process of manufacturing marble. Use of marble powder does not only reduce the cost of construction but also helps to reduce the impact on environment by consuming the material generally considered as waste product.

This project is based on the replacement of cement with marble powder dust that is available as waste from manufacturing of marble. This replacement is done to increase the strength of the concrete and using the marble waste economical

Keywords- Cement, FlyAsh, Marble Dust, Indirect Tensile Test, Compressive strength, Flexural Stength.

I. INTRODUCTION

Nowadays, concrete made with Portland cement is probably the most widely used man made material in the world. Despite this fact, concrete production is one of the concerns worldwide that impact the environment with major impact being global warming due to CO_2 emission during production of cement. It is estimated that cement production is responsible for about 3% of the global and throgenic greenhouse gas emission and for 5% of the global anthrogenic CO_2 emission.As about 50% of the CO_2 released during cement production is related to the decomposition of limestone during burning, mixing of clinker with supplementary materials called blending is considered as a very effective way to reduce CO_2 emission

Most common blending materials used in cement production added in plant or sites are industrial wastes. This is due to the fact that recycling of industrial wastes as blending materials has technical, economical and environmental benefits besides the reduction of CO_2 emission from cement production

Cement consist of grinding the raw materials, mixing them intimately in certain proportions depending upon their purity and composition and burning them in kiln at a temperature about 1300to 1500^0C,at which temperature, the material sinters and partially fuses to form nodular shaped clinker. The clinker is cooled and ground to fine powder with additions of about 3 to 5% of gypsum. The product formed by using this procedure is Portland cement.

There are two processes known as “wet” and “dry” processes depending upon whether the mixing and grinding of raw materials is done in wet or dry conditions. With a little change in the above process we have the semi-dry process also where the raw materials are ground dry and then mixed with about 10-14 per cent of water and further burnt to clinkering temperature.

Concrete is strength and tough material but it is porous material also which interacts with the surrounding Environment. The durability of concrete depends largely on the movement of water and gas enters and moves through it. The permeability of concrete depends on its pores structure even the best of concrete is not gas tight or water tight. The permeability is an indicator of concrete’s ability to transport water more precisely with both mechanism that is controlling the uptake and transport of water and gaseous substances into cementitious material. Permeability is a measure of flow of water under pressure in a saturated porous medium while Sorptivity is materials ability to absorb and transmit water through it by capillary suction.

Marble industry produces large amounts of waste marble e what causes environmental problems. In paving blocks based on two cement types we have partly replaced aggregate with waste marble. Physical and mechanical tests were performed on blocks so produced. The cement type turns out to be an important factor. Mechanical strength decreases with increasing marble content while freeze-that durability and

abrasive wear resistance increase. Waste marble is well usable instead of the usual aggregate in the concrete paving block production.

The marble has been commonly used as a building material since ancient times. Disposal of the waste materials of the marble industry, consisting of very fine powders, is one of the environmental problems worldwide today. However, these waste materials can be successfully and economically utilized to improve some properties of fresh and hardened self-compacting concrete (SCC). The technical importance of using wastes and by-products in concrete production is expressed by performance improvement of concrete. The economical benefit usually attributes to the reduction of the amount of expensive and or scarce ingredients with cheap materials. Environmentally, when industrial wastes are recycled not only the CO_2 emissions are reduced but residual products from other industries are reused and therefore less material is dumped as landfill and more natural resources are saved.

1.2. Production of Marble, as Dimensional Stone, in Rajasthan:

The term "dimensional stone" is defined by United States Bureau of Mines as naturally occurring rock material cut, shaped or selected for use in blocks, slabs, sheets or other construction units of specified shapes or sizes and used for external or interior parts of buildings, foundations, curbing, paving, flogging, bridges, revetments or other architectural or engineering purposes. The term is also applied to quarry blocks from which pieces of fixed dimensions may be cut.

Marble, granite, limestone, and sandstone provide the bulk of dimensional stone; although slate, diorite, basalt and diabase are included. The classification of dimensional stone is not strictly adhered to sedimentary, igneous and metamorphic grouping of geology, as the stone trade name under "granite" refers to all true granite and gabbro, norite, and syenite. Likewise all crystalline limestone, travertine, sandstone and serpentine that are capable of taking a polish are grouped under marble in addition to the true marble.

The commercial definition of marble refers to all crystalline rocks predominantly composed of calcite, dolomite, or serpentine. The root word for marble-mar more-was used by the Italians in ancient Rome, referring to all hard rock's capable of taking a polish including granite. However, marble in the geologic usage is a metamorphosed limestone or dolostone, which obliterated its original texture due to intensive re-crystallization.

1.3. Scope of the project:

There are two types of by-products of marble processing. During marble processing, 30% of the stone (in case of unprocessed stone) goes to scrap because of being smaller size and/or irregular shape. This is then sold to chip manufacturers. In case of semi-processed slab, the scrap level reduces to 2-5%. The other waste material is slurry. It is basically the water containing marble powder. The water is reused till it gets thick enough (70% water and 30% marble powder) to be reused. In addition to loss, disposal of this waste material will cause the following environmental problems:

a) If the waste is disposed on soils, the porosity and permeability of topsoil will be reduced, the fine marble dust reduces the fertility of the soil by increasing its alkalinity.
b) When the waste is dumped and dried out, the fine marble dust suspends in the air and slowly spread out through wind to the nearby area.
c) When dumped along a catchment area of natural rainwater, it results in contamination of over ground water reservoir and also cause drainage problem.

Currently there are more than four marble processing plants in Rajasthan located in different towns. The Rajasthan Marble Processing Enterprise and R.K Marble are located in Kishangarh. The Rajasthan Marble Processing Enterprise has three branches located at Kankroli ,BaniSapole and Albeta sub city.For instance Ordinary Portland cement and Portland Pozzolana cement types are the only product produced by cement factories and found on the market for all types of work which is expensive and uneconomical [1]. Trials to solve cement shortage only by increasing cement factories have another negative environmental impact due to the emission of CO_2 from the factories.

1.4. Objectives of the study:

In this project our main objective is to study the influence of partial replacement of cement with marble powder, and to compare it with the compressive and tensile strength of ordinary M_{20} concrete. We are also trying to find the percentage of marble powder replaced in concrete that makes the strength of the concrete maximum.

Nowadays marble powder has become a pollutant. So, by partially replacing cement with marble powder, we are proposing a method that can be of great use in reducing pollution to a great extent.

1. To study the influence of replacement of cement by marble waste powder on compressive, Flexural strength& tensile strength of M20 grade concrete.

2. To find the optimum percentage of replacement of cement with marble waste powder, so that the strength of concrete is maxi

II. LITERATURE REVIEW

ABRAR AWOL (2011) HAVE DONE THEIR RESEARCH ON USING MARBLE WASTE POWDER IN CEMENT AND CONCRETE PRODUCTION.They found that replacement of cement by marble waste powder at 5% range, in concrete production, results in comparable compressive strength as of concrete specimens without marble waste powder with slight slump reduction for both C-25 and C-50 classes. Increment of replacement ranges beyond 5%, in concrete production, results in reduction of compressive strength and slump and the replacement of sand by marble waste powder from 5-20% ranges, in concrete production, results in similar and mostly enhanced performance than the control concrete specimens; with similar compressive strength to the control specimens, with slump improvement and water permeability depth reduction than the control specimens in both C-25 and C-50 classes.

BABOORAI ET.AL(2011) have done their research on INFLUENCE OF MARBLE POWDER/GRANULES IN CONCRETE MIX .They found that using marble powder and granules as constituents of fines in mortar or concrete by partially reducing quantities of cement as well as other conventional fines in terms of the relative workability & compressive as well as flexural strengths. Partial replacement of cement and usual fine aggregates by varying percentage of marble powder and marble granules reveals that increased waste marble powder or waste marble granule ratio result in increased workability and compressive strengths of the mortar and concrete.

NAGABHUSHANA ET.AL (2011) have done their research on USE OF CRUSHED ROCK POWDER AS REPLACEMENT OF FINE AGGREGATE IN MORTAR AND CONCRETE . They found that The present the properties of mortar and concrete in which Crushed Rock Powder (CRP) is used as a partial and full replacement for natural sand. For mortar, CRP is replaced at 20% 40%, 60%, 80% and 100%. The basic strength properties of concrete were investigated by replacing natural sand by CRP at replacement levels of 20%, 30% and 40%.

OMAR M. OMAR ET.AL (2012) have done their research on INFLUENCE OF LIMESTONE WASTE AS PARTIAL REPLACEMENT MATERIAL FOR SAND AND MARBLE POWDER IN CONCRETE PROPERTIES.They found that the replacement proportion of sand with limestone waste, 25%, 50%, and 75% were in the concrete mixes except in the concrete mix. Besides, proportions of 5%, 10% and 15% marble powder were replaced in the concrete mixes..The investigation test of compressive strength, indirect tensile strength, flexural strength, modulus of elasticity, and permeability. It was found that limestone waste as fine aggregate enhanced the slump test of the fresh concretes. But the unit weight concretes were not affected. However, the good performance was observed when limestone waste as fine aggregate was used in presence of marble powder.

ANIMESH MISHRA ET.AL (2013) have done their research on GREEN CEMENT FOR SUSTAINABLE CONCRETE USING MARBLE DUST. They found that Marble sludge powder can be used as filler and helps to reduce the total voids content in concrete and the feasibility of the usage of marble sludge dust hundred percent substitutes for natural sand in concrete. The compressive strength and microstructure of blended cement was investigated in this study. The hydration products of cements were identified by means of scanning electron microscopy. It was found that the blended cements developed higher strength, at 28 days compared to 7 days. The strength increase was higher, the higher the marble dust content. So, concrete prepared by marble dust which helpful to reduce consumption of natural resources and energy and pollution of the environment.

ANKIT NILESHCHANDRA PATEL (2013) have done their research on STONE WASTE IN INDIA for Concrete with Value Creation Opportunities. They found that the OPC cement has been replaced by stone waste accordingly in the range of 0%, 10%, 20%, 30%, 40%, & 50% by weight for M-25 grade concrete. Concrete mixtures were produced, tested and compared in terms of workability and strength to the conventional concrete. These tests were carried out to evaluate the mechanical properties for 7, 14 and 28 days. As a result, the compressive increased up to 30% replacing of stone waste. This research work is concerned with the experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing OPC cement via 0%, 10%, 20%, 30%, 40% and 50% of stone waste. They found the behavior of concrete while replacing of waste with different proportions of stone waste in concrete by using tests like compression strength.

DEBORAH .O.OLANREWAJU (2013) have done their research on EXPERIMENTAL STUDY ON THE PARTIAL REPLACEMENT OF CEMENT BY MARBLE DUST ON CONCRETE . They found that the partial replacement of Portland Cement 0,5,10 and 20% with marble dust. The results so far have yielded some benefits for its use in construction works. The study presents an initial understanding of the

current strengths and weaknesses of the concrete with marble dust.

DR.G.PRINCE ARULRAJ ET.AL (2013) have done their research on GRANITE POWDER CONCRETE .They found that the granite powder waste can be utilized for the preparation of concrete as partial replacement of sand. In order to explore the possibility of utilizing the granite powder as partial replacement to sand.The percentages of granite powder added by weight to replace sand by weight were 0, 5, 10, 15, 20 and 25. To improve the workability of concrete 0.5% Superplasticiser was added. 54 cubes and 36 cylinders were cast. Compressive strength and split tensile strength were found. The test results indicate that granite as replacement of sand with granite powder has beneficial effect on the mechanical properties such as compressive strength and split tensile strength of concrete.

ER. TANPREET SINGH ET.AL (2013) have done their research on INFLUENCE OF MARBLE POWDER ON MECHANICAL PROPERTIES OF MORTAR AND CONCRETE MIX.They found that using waste materials from different manufacturing activities in the preparation of innovative mortar and concrete. The use of waste marble powder (dust) was proposed in partial replacement of cement, for the production of Mortar and Concrete Mix. In particular, tests they were conducted on the mortars and concrete mix cured for different times in order to determine their workability, flexural as well as compressive strength. Partial replacement of cement by varying percentage of marble powder reveals that increased waste marble powder ratio result in increased workability and compressive strengths of the mortar and concrete.

NOHA M. SOLIMANȦ (2013) have done their research on EFFECT OF USING MARBLE POWDER IN CONCRETE MIXES ON THE BEHAVIOR AND STRENGTH OF R.C. SLABS.They found that the use of marble powder as partially replace of cement on the properties of concrete. The influence of using marble powder on the behavior of reinforced concrete slabs is also investigated. The main variable taken into consideration is the percentage of marble powder as partial replacement of cement content in concrete mixes. They shows that, using definite amount of marble powder replacement of cement content increases the workability, compressive strength and tensile strength and used of marble powder enhanced also the structural performance of the tested slabs as it increased the stiffness and the ultimate strength compared to the control slabs.

NUTAN PATEL ET.AL(2013) have done their research on MARBLE WASTE OPPORTUNITIES FOR DEVELOPMENT OF LOW COST CONCRETE. They found that Marble waste is estimated that there are million tons of quarrying waste are produced in each year. Although a portion of this waste may be utilized on-site such as for excavation pit refill. Waste generated at quarries and fabrication plants is quite similar. Most commonly, scrap stone must be mitigated and managed, but attention must be paid to other types of wastes, as well. These include marble sludge/slurry. Marble sawing powder wastes is widespread by-product of industrial process in India. Generally these wastes pollute and damage the environment due to sawing and polishing processes. This waste is used for making a marble waste concrete. The main aim of this research is waste management is to evaluate recovery and use marble waste in making a low cost concrete.

VAIDEVI C (2013) have done their research on STUDY ON THE MARBLE DUST AS PARTIALLY REPLACEMENT OF CEMENT IN CONCRETE .They found that the marble dust from marble processing is a waste utilized. The use of this waste was proposed in different percentages both as an addition to and instead of cement, for the production of concrete mixtures. In this study, the use of marble dust collected during the shaping process of marble blocks has been investigated in the concrete mixtures as cementitious material. The study showed that marble wastes, which are in the dust form, could be used as cementitious material in concrete mixtures where they are available and the cost of construction is lower than ordinary concrete materials. The concrete is prepared containing 5, 10, 15 and 20% waste of marble dust with cement compared to the total quantity of normal concrete. The prepared mixtures were then studied in terms of their properties both in fresh and in hardened state. In this particular, tests they conducted and cured at different times to find compressive strength and tensile strength with and without partial replacement of marble dust in cement concrete and for mortar also determined for 14 and 28 days.

V.M.SOUNTHARARAJAN ET.AL(2013) have done their research on EFFECT OF THE LIME CONTENT IN MARBLE POWDER FOR PRODUCING HIGH STRENGTH CONCRETE. They found that the waste marble powder up to 10% by weight of cement was investigated for hardened concrete properties. Furthermore, the effect of different percentage replacement of marble dust on the compressive strength, splitting tensile strength and flexural strength was evaluated. It can be noted that the influence of fine to coarse aggregate ratio and cement-to-total aggregate ratio had a higher influence on the improvement in strength properties. A phenomenal increase in the compressive strength of 46.80 MPa at 7 days for 10% replacement of marble powder in cement content was noted and also showed an improved mechanical property compared to controlled concrete.

PROF. VEENA G. PATHAN (2014) have done their research on FEASIBILITY AND NEED OF USE OF WASTE MARBLE POWDER IN CONCRETE PRODUCTION. They found that the Compressive strength and Split Tensile strength of Concrete can be increased with addition of waste marble powder up to 10% replace by weight of cement and also the effects of blending marble waste on the properties of cement such as consistency, setting times, insoluble residue, and soundness remain within the acceptable ranges of different standards. The production of cheaper and more durable concrete using this waste can solve to some extent the ecological and environmental problems. Therefore it provides a scope for more research which is required to design consistent and durable concrete with this waste.

III. METHODOLOGY

Fundamental for the formation of the whole project work, a comprehensive literature review is made to understand the previous efforts which include the review of text books, periodicals and academic journals, and research papers.

The method In order to achieve the objectives of the project and for the development of concepts, which are followed to achieve the objectives of the project, determines the required data, which intern is a ground to decide on type and method of data collection and their analysis. Different alternative data collection methods such as experiments, observations and archival records are examined and used when proved suitable.

Both primary data (collected personally) from the source itself and secondary data from different sources is collected and used for the analysis. The test results were presented in tabular and graphical forms and the analysis and discussions were also made on the project findings both qualitatively and quantitatively. Finally based on the findings, conclusions and recommendations were forwarded.

Step 1: we check the properties of the material used in the concrete mix design.

(a) Specific gravity of the cement
(b) Initial and final setting time of the cement
(c) Standard consistency of the cement
(d) Sieve analysis of the coarse aggregate and Sand.
(e) Specific Gravity of Marble powder
(f) Apparent Specific gravity of aggregate
(g) check the consistency of cement

Step 2: Prepare a M 20 Mix design

(a) By weight
(b) Check the slump value
(c) Comp. Strength and Split Tensile Strength of the mix design in 7 days 14 Days And 28day resp.

Step 3: Casting of Cubes and Cylinders

Total number 36 cubes, beam 24 and 24 cylinders will be casted in a concrete lab. Marble powder will be added in concrete in step of4% (0%, 5%,10%and 15%). For each percent of marble powder replacing cement, will be casted for 7 days,14days& 28 days. Final strength of cube, beam & cylinder will be tested after 7, 14 & 28 days of curing. Compression testing machine is used for testing the compressive strength of cube, flexural strength of beams and split tensile strength of cylinder.

Step 4:

The Crushing loads will be noted and average compressive strength, flexural strength and tensile strength for three Specimens will be determined for each.

Step 5:

The test result will be presented in tabular and graphical forms.

Structure of the project:

The project has six chapters that discuss various aspects of cement and concrete related with relevance of the project. Chapter one explains the background and the objectives of the project. Chapter two is literature review which provides a general understanding of previous studies and theories related to the project.

Economical and Environmental:

Recycling of industrial wastes has actually environmental, economical and technical benefits. These benefits can be seen from two different angles, one from the point of the waste producer and the other from the user part. For the producer, the benefits of recycling industrial wastes are economical and environmental; for the user additional technical benefits may be attained from recycling. For the producer, the environmental benefit can be attained as far as the waste is recycled. It is independent of where it is recycled. But the economical benefit is determined on the demand for the waste by different users. The more users, the more demand will be; there by more economical benefit to the producer. With respect to the user, recycling of industrial wastes will be environmentally beneficial as far as using the waste reduces waste emitted during production of similar product from other

raw alternative materials. The economical benefit is assured if the cost of the waste material is cheaper than other alternative raw materials. The technical benefit is also attained if the recycled input improves the quality of the output than the output from other alternative material. Therefore it is necessary to see recycling of marble waste powder with respect to both the producer and the user part.

For the Marble Waste Powder Producer:

The producer of a waste will ensure environmental benefits as far as the waste is recycled. It is also expected that it can get more economical benefits when there is more demand for the waste. Therefore, the use of marble waste in the construction industry undoubtedly will increase the demand for the waste thereby benefits the producer both environmentally and economically.

For the Construction Industry:

- **Environmental Benefits:**

One of the greatest environmental concerns in construction industry is the production of cement which emits large amount of CO_2 gas to the atmosphere. It is estimated that 1 tone clinker production releases 1 tone CO_2 [21] .Mixing of clinker to supplementary materials called blending is considered as a very effective way to reduce CO2 emission [18] It is estimated that The Rajasthan Marble Processing Enterprise produces 1800m^3 (4500 tons) marble waste annually, which implies that using marble waste of The Rajasthan Marble Processing Enterprise as cementreplacing material can indirectly reduce CO2 emission to the atmosphere by 4500 tons annually. Recycling marble waste powder in substitution of sand also indirectly can reduce environmental problem related with sand production.

- **Economical Benefits:**

In this Project work, detail cost break down and economical analysis was not worked out as the cost of cement and sand depends on its user point location and also due to lack of necessary data and required information; but to give insight for cost benefits, the average cost of cement, sand and selling price of marble waste is presented below in Table 1.1.

Table 1: Average price of cement, sand and marble waste

Sr.no	Type of Material	Average Price
1.	Cement	640 per Quintal
2.	Sand	220 Per m^3
3.	Marble Powder	50 Per Quintal

The above figures clearly show that using of marble waste in replacement of cement can play cost reduction in concrete production.

IV. EXPERIMENTAL STUDIES

Compressive Strength Test

Test Procedure:

The following testing procedure was undertaken during the modified cube compression testing:

- The measuring and testing of test specimens was undertaken as soon as possible after being removed from the curing tank.
- All specimens were tested in a wet condition and excess water removed from the surface.
- The dimensions of the test specimens were measured and recorded.
- The platens were cleaned when necessary to ensure no obstruction from small particles or grit.
- Any loose particles were removed from the uncapped bearing surfaces of the specimens.
- It was ensured there was no trace of lubricant on the bearing surfaces.
- The 150 x 150 mm plate was placed on top and bottom of the beam directly opposite each other.
- The specimens were centered on the bottom platen of the testing machine.
- The upper platen was lowered until uniform pressure was provided on the specimen.
- A force was applied at the required rate shown by the rotating disc on the testing machine.
- The maximum force applied to the cylinder was recorded and the compressive strength calculated : pressure = FORCE / AREA

Figure 4.1 Compressive Test

Indirect Tensile Test:

Testing Procedure:

The procedure used to conduct the indirect tensile test follows:

- The diameters of specimen in the plane in which it is being tested as well as the lengths where the bearing strips are in contact were determined.
- The bearing strips between the testing jig and the test specimen were aligned.
- The testing jig was centred in the compression machine and the top platen was lowered.
- A small force was applied to ensure correct seating was achieved.
- The force was at the required rate without shock (shown on inner disc of machine).
- The maximum force applied to the concrete before failure was recorded.
- The fracture type and appearance of concrete was also recorded.
- The indirect tensile strength of the specimen was calculated using the following equationT 2 P/LD

Figure 4.2 Indirect Tensile Test Machine

Flexural strength test:

The following testing procedure was undertaken during the flexural strength testing:

1. Test specimens shall be prepared by moldings concrete to a beam section, curing and storing in accordance with standard procedure. The section of the beam shall be square of 100 mm or 150 mm. The overall length of the specimen shall be 4d to 5d. The ratio of d to the maximum particle size of aggregate shall be not less than three.
2. Circular rollers manufactured out of steel having cross section with diameter 38 mm will be used for providing support and loading points to the specimens. The length of the rollers shall be at least 10 mm more than the width of the test specimen. A total of four rollers shall be used, three out of which shall be capable of rotating along their own axes. The distance between the outer rollers (i.e. span) shall be 3d and the distance between the inner rollers shall be d. The inner rollers shall be equally spaced between the outer rollers, such that the entire system is systematic.
3. The specimen stored in water shall be tested immediately on removal from water; whilst they are still wet. The test specimen shall be placed in the machine correctly centered with the longitudinal axis of the specimen at right angles to the rollers. For moulded specimens, the mould filling direction shall be normal to the direction of loading.
4. The load shall be applied slowly without shock at such a rate as to increase the stress at a rate of .06 + .04 N/mm^2 per second.

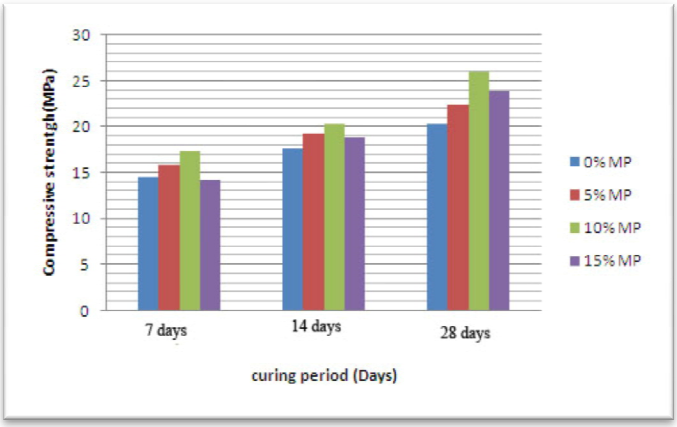
The Flexural Strength is given by ,$\mathbf{f_b = pl/bd^2}$

V. RESULTS AND DISCUSSION

Table 2: Comparison of Compressive strength of Cubes for different mixes

Curing Period (Days)	0% of Marble Powder	5% of Marble Powder	10% of Marble Powder	15% of Marble Powder
7	14.55	15.88	17.24	14.24
14	17.96	19.24	20.24	18.84
28	20.36	22.44	25.94	23.86

Comparison of Compressive strength of Cubes for different mixes



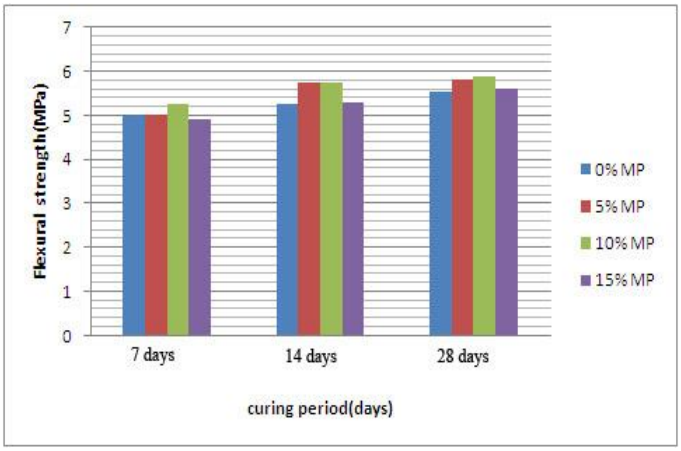
From table 2 when compared to control specimen, it was observed that compressive strength increased by 5%, 10% of marble powder mix respectively at 7 days curing period. Similarly, it was observed that compressive strength increased

by 5%,10% of marble powder mix respectively at 14 days curing period. & It was observed that compressive strength increased by 5%, 10%&15% of marble powder mix respectively at 28 days curing period.

Table 3: Comparison of Flexural strength of Prism for different mixes

Curing Period (Days)	0% of Marble Powder	5% of Marble Powder	10% of Marble Powder	15% of Marble Powder
7	5	5	5.25	4.9
14	5.25	5.75	5.75	5.3
28	5.5	5.8	5.9	5.6

Comparison of Flexural strength of Prism for different mixes

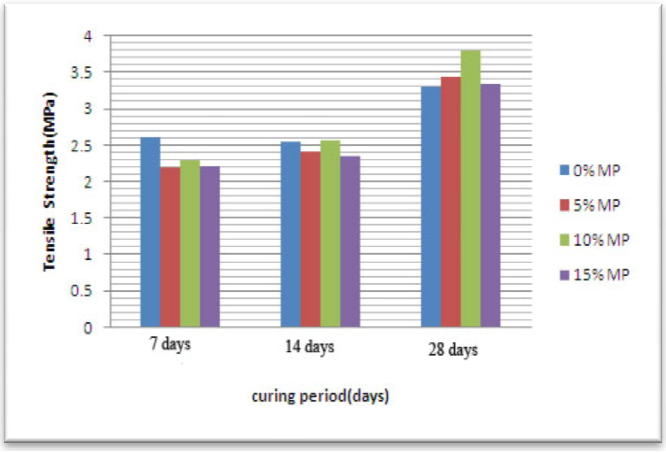


From table 3 when compared to control specimen, it was observed that flexural strength increased by 10% of marble powder mix respectively at 7 days curing period. Similarly**,** it was observed that flexural strength increased by 5%,10% &15% of marble powder mix respectively at 14 days curing period. & It was observed that flexural strength increased by 5%, 10%&15% of marble powder mix respectively at 28 days curing period.

Table 4 Comparison of Indirect Tensile of Cylinders for different mixes

Curing Period (Days)	0% of Marble Powder	5% of Marble Powder	10% of Marble Powder	15% of Marble Powder
7	2.26	2.19	2.28	2.20
14	2.55	2.40	2.56	2.35
28	3.3	3.45	3.8	3.35

Comparison of Indirect Tensile of Cylinders for different mixes



From table 4 when compared to control specimen, it was observed that tensile strength increased by 10% of marble powder mix respectively at 7 days curing period. Similarly**,** it was observed that tensile strength increased by 10% of marble powder mix respectively at 14 days curing period. & It was observed that tensile strength increased by 5%, 10%&15% of marble powder mix respectively at 28 days curing period.

V. CONCLUSION

- The Compressive strength of Cubes are increased with addition of waste marble powder up to 10% replace by weight of cement and further any addition of waste marble powder the compressive strength decreases.
- The Split Tensile strength of Cylinders are increased with addition of waste marble powder up to 10% replace by weight of cement and further any addition of waste marble powder the Split Tensile strength decreases.
- The Flexural strength of prisms are increased with addition of waste marble powder up to 10% replace by weight of cement and further any addition of waste marble powder the compressive strength decreases
- Thus we found out the optimum percentage for replacement of marble powder with cement and it is almost 10%cement for both cubes and cylinders.
- We have put forth a simple step to minimize the costs for construction with usage of marble powder which is freely or cheaply available; more importantly.

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